

What is claimed is:

1. A composite rare-earth anisotropic bonded magnet, comprising:

(A) Cobalt-less R1 d-HDDR coarse powder with an average grain diameter of 40-200 μm , comprising:

1. Cobalt-less R1 d-HDDR anisotropic magnet powder, obtained by performing a d-HDDR treatment on a cobalt-less R1 alloy of a rare-earth element including yttrium (Y) (hereafter, "R1"), iron (Fe), and boron (B) as the main ingredients and fundamentally not containing cobalt; and
2. #1 surfactant that coats at least one part of the grain surface of said cobalt-less R1 d-HDDR anisotropic magnet powder; and

(B) R2 fine magnet powder with an average aspect ratio of 2 or less and average grain diameter 1-10 μm , comprising:

1. R2 anisotropic magnet powder with a maximum energy product $(BH)_{\max}$ 240kJ/m³ or more and with a rare-earth element including yttrium (hereafter, "R2") as one of the principle ingredients; and
2. #2 surfactant that coats at least one part of the grain surface of said R2 anisotropic magnet

Powder and

(C) a resin as binder; wherein

the said bonded magnet contains 50-84 wt% of said Co-less R1 d-HDDR coarse magnet powder, 15-40 wt% of said R2 fine magnet powder, and 1-10 wt% of said resin; and wherein

relative density (ρ / ρ_{th}) of the said bonded magnet, which is the ratio of volume density (ρ) to theoretical density (ρ_{th}), is 91-99%; and wherein

normalized grain count of the said Co-less R1 d-HDDR coarse magnet powder in the said bonded magnet, where per unit area apparent grain diameter is 20 μm or less, is 1.2×10^9 pieces/ m^2 or less;

the said composite rare-earth anisotropic bonded magnet having the special characteristics of outstanding magnetic properties and heat tolerance.

2. The composite rare-earth anisotropic bonded magnet recited in claim 1, wherein the above-mentioned R2 anisotropic magnet powder is SmFeN anisotropic magnet powder having samarium (Sm), iron (Fe), and nitrogen (N) as the main ingredients.

3. The composite rare-earth anisotropic bonded magnet recited in claim 1, wherein the above-mentioned R2 anisotropic magnet powder is Co-less R2 d-HDDR anisotropic magnet powder, obtained by performing a d-HDDR treatment on a Co-less R2 alloy having R2, Fe, and B as the main ingredients and fundamentally not containing cobalt.

4. The composite rare-earth anisotropic bonded magnet recited in claim 1 or claim 3, wherein when taking the whole as 100at%, at least one of the above Co-less R1 d-HDDR anisotropic magnet powder or above R2 anisotropic magnet powder includes 0.05-5at% of one or more of the rare-earth elements (hereafter, "R3") consisting of dysprosium (Dy), terbium (Tb), neodymium (Nd), and praseodymium (Pr).

5. The composite rare-earth anisotropic bonded magnet recited in claim 1 or claim 3, wherein when taking the whole as 100at%, at least one of the above Co-less R1 d-HDDR anisotropic magnet powder or above R2 anisotropic magnet powder includes 0.01-1.5at% of Lanthanum (La).

6. The rare-earth anisotropic bonded magnet recited in claim

1 or claim 3, wherein at least one of the above Co-less R1 d-HDDR anisotropic magnet powder or above Co-less R2 d-HDDR anisotropic magnet powder includes 0.001-6.0at% of Co.

7. A composite rare-earth anisotropic bonded magnet compound comprising:

(A) Cobalt-less R1 d-HDDR coarse magnet powder having an average grain size of 40-200 μm , comprising:

1. Cobalt-less R1 d-HDDR anisotropic magnet powder, obtained by performing a d-HDDR treatment on a cobalt-less R1 alloy with R1, Fe, and B as the main ingredients and fundamentally not containing cobalt; and
2. said #1 surfactant that coats at least one part of the grain surface of said cobalt-less R1 d-HDDR anisotropic magnet powder; and

(B) R2 fine magnetic powder with an average aspect ratio of 2 or less and average grain diameter 1-10 μm , comprising:

1. R2 anisotropic magnet powder with a maximum energy product $(BH)_{\max}$ of 240kJ/m³ or more and with R2 as one of the main ingredients; and

2. #2 surfactant that coats at least one part of the grain surface of said R2 anisotropic magnet powder; and

(C) a resin as binder; wherein

the said compound contains 50-84 wt% of said Co-less R1 d-HDDR coarse magnet powder, 15-40 wt% of said R2 fine magnet powder, and 1-10 wt% of said resin; and

the said compound having a composition that direct contact between grains of the said Co-less R1 d-HDDR coarse magnet powder is avoided by enveloping the grains a ferromagnetic buffer which said R2 fine magnet powder uniformly disperses in the said resin.

8. The composite rare-earth anisotropic bonded magnet compound recited in claim 7, wherein the above R2 anisotropic magnet powder is SmFeN anisotropic magnet powder having Sm, Fe, and N as the main ingredients.

9. The composite rare-earth anisotropic bonded magnet compound recited in claim 7, wherein the above R2 anisotropic magnet powder is Co-less R2 d-HDDR anisotropic magnet powder obtained by performing a d-HDDR treatment on

a Co-less R2 alloy having R2, Fe, and B as the main ingredients and fundamentally not containing cobalt.

10. The composite rare-earth anisotropic bonded magnet compound recited in claim 7 or claim 9, wherein when taking the whole as 100at%, at least one of the above Co-less R1 d-HDDR anisotropic magnet powder or above R2 anisotropic magnet powder includes 0.05-5at% of R3.

11. The composite rare-earth anisotropic bonded magnet compound recited in claim 7 or claim 9, wherein when taking the whole as 100at%, at least one of the above Co-less R1 d-HDDR anisotropic magnet powder or above R2 anisotropic magnet powder includes 0.01-1at% of La.

12. The composite rare-earth anisotropic bonded magnet compound recited in claim 7 or claim 9, wherein either the above Co-less R1 d-HDDR anisotropic magnet powder or above Co-less R2 d-HDDR anisotropic magnet powder includes 0.001-6.0at% of Co.

13. The composite rare-earth anisotropic bonded magnet compound recited in claim 7; which is used in the production

of the composite rare-earth anisotropic bonded magnet recited in claim 1.

14. A production method for a composite rare-earth anisotropic bonded magnet, that production method comprising:

(1) A heat orientation process performed on a compound in which direct contact between grains of the said Co-less R1 d-HDDR coarse magnet powder is avoided by enveloping the grains in a ferromagnetic buffer made by uniformly dispersing the said R2 fine magnet powder in the said resin, the compound comprising:

(A) 50-84 wt% of Cobalt-less R1 d-HDDR coarse magnet powder having an average grain size of 40-200 μm , comprising:

1. Cobalt-less R1 d-HDDR anisotropic magnet powder, obtained by performing a d-HDDR treatment on a cobalt-less R1 alloy with R1, Fe, and B as the main ingredients and fundamentally not containing cobalt; and
2. said #1 surfactant that coats at least one part of the grain surface of said cobalt-less R1 d-HDDR anisotropic magnet powder; and

(B) 15-40 wt% of R2 fine magnetic powder with an average

aspect ratio of 2 or less and average grain diameter 1-10 μ m, comprising:

1. R2 anisotropic magnet powder with a maximum energy product $(BH)_{max}$ of 240 kJ/m³ or more and with R2 as one of the main ingredients; and
2. #2 surfactant that coats at least one part of the grain surface of said R2 anisotropic magnet powder; and

(C) 1-10 wt% of resin as binder; wherein

in the said heat orientation process the compound is heated above the softening point of the resin which forms the said ferromagnetic buffer, and while keeping the said ferromagnetic buffer in a softened state or melted state, an orienting magnetic field is applied so that the said Co-less R1 d-HDDR coarse magnet powder and said R2 fine magnet powder are oriented in a specific direction; and

(2) a heat molding process in which, after said heat orientation process or in parallel with said heat orientation process, the compound is heated and press molded; wherein in the said production method:

normalized grain count of the said Co-less R1 d-HDDR coarse magnet powder in the said bonded magnet, where per unit

area apparent grain diameter is 20 μm or less, is 1.2x10⁹ pieces/m² or less; and

relative density (ρ / ρ_{th}) of the said bonded magnet, which is the ratio of volume density (ρ) to theoretical density (ρ_{th}), is 91-99%; and wherein

the said production method obtained a composite rare-earth anisotropic bonded magnet with excellent magnetic properties and heat resistance.

15. The production method for the composite rare-earth anisotropic bonded magnet recited in claim 14, wherein in the above mentioned heat orientation process, the green compact, which press molds the above-mentioned compound, is heated and the magnetic field of the green compact is oriented.

16. A production method for a composite rare-earth anisotropic bonded magnet compound, that production method comprising:

(1) A mixing process which combines and mixes:

(A) Cobalt-less R1 d-HDDR coarse magnet powder having an average grain size of 40-200 μm , comprising:

1. Cobalt-less R1 d-HDDR anisotropic magnet powder, obtained by performing a d-HDDR treatment on a cobalt-less R1 alloy with R1, Fe, and B as the main ingredients and fundamentally not containing cobalt; and
2. said #1 surfactant that coats at least one part of the grain surface of said cobalt-less R1 d-HDDR anisotropic magnet powder; and

(B) R2 fine magnetic powder with an average aspect ratio of 2 or less and average grain diameter 1-10 μm , comprising:

1. R2 anisotropic magnet powder with a maximum energy product $(BH)_{\max}$ of 240 kJ/m³ or more and with R2 as one of the main ingredients; and
2. #2 surfactant that coats at least one part of the grain surface of said R2 anisotropic magnet powder; and

(C) a resin as binder; wherein

the ingredients are mixed in a ratio of 50-84 wt% of said Co-less R1 d-HDDR coarse magnet powder, 15-40 wt% of said R2 fine magnet powder, and 1-10 wt% of said resin; and

(2) a heat kneading process in which after the said mixing process, the mixture is heated to a temperature above the softening point of the said resin, and then kneaded; wherein

the said production method obtained a compound in which direct contact between grains of the said Co-less R1 d-HDDR coarse magnet powder is avoided by enveloping the grains in a ferromagnetic buffer in which said R2 fine magnet powder is uniformly dispersed in the resin.